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Table 1

Crystal	λp (μm)	Δλs (μm)	Δλi (μm)	Axis of rotation of the cylinder	Angle of rotation Δα (°)	αmin (°)
$KTiOPO_4$	0.532 (-)	0.62-1.04 (+)	1.09-3.5 (-)	Y	46	44
$KTiOPO_4$	1.064 (-)	1.53-2.12 (+)	2.13-3.5 (-)	Y	7	45.5
$CsTiOAsO_4$	0.532 (-)	0.59-0. 74 (+)	1.9-5.2 (-)	Y	39	51
$CsTiOAsO_4$	1.064 (-)	1.33-2.12 (+)	2.13-5.2 (-)	Y	15	51.5
$RbTiAsO_4$	0.532 (-)	0.59-0.355 (+)	1.41-5.2 (-)	Y	49	41
$RbTiAsO_4$	1.064 (-)	1.33-2.12 (+)	2.13-5.2 (-)	Y	9.3	44.5
$RbTiOPO_4$	0.532 (-)	0.62-0.95 (+)	1.21-3.5 (-)	Y	45	45
$RbTiOPO_4$	1.064 (-)	1.52-2.12 (+)	2.43-3.5 (-)	Y	3.3	49.5
$LiNbO_4$	0.532 (-)	0.59-0.70 (+)	2.2-5.2 (-)	Y (or X)	40	50
$LiNbO_4$	1.054 (-)	1.33-2.12 (+)	2.13-5.2 (-)	Y (or X)	21	57
$KTiOPO_4$	0.532 (-)	0.95-1.16 (-)	1.06-1.2 (-)	Z	57	23
$KTiOPO_4$	1.064 (-)	1.52-1.53 (-)	3.25-3.5(-)	Z	90	0
$CsTiOAsO_4$	0.532 (-)	0.74-0.84 (-)	1.45-1.9 (-)	Z	90	0
$CsTiOAsO_4$	1.064 (-)	1.7-2.0 (-)	2.27-2.8 (-)	Z	90	0
$RbTiOPO_4$	0.532	0.855-0.955 (-)	1.2-1.41 (-)	Z	90	0
$RbTiOPO_4$	1.054 (-)	1.54-1.01 (-)	3.15-3.4 (+)	Z	90	0
$RbTiAsO_4$	0.532 (-)	0.95-1.06 (-)	1.06-1.22 (-)	Z	60	0
$RbTiAsO_4$	1.064 (-)	1.61-1.69 (-)	2.35-3.15 (+)	Z	90	0
$KTiOAsO_4$	0.532 (-)	0.96-1.04 (+)	1.09-1.19 (+)	Z	90	0
$KTiOAsO_4$	1.064 (-)	1.55-1.60 (-)	3.15-3.38 (+)	Z	90	0

(+) and (-) refer to indexes of refraction n^+ and n^- defined in Example 1, which are involved in the phase tuning relationship.

The case of a tunable OPO in the range 1.4 μm - 5.2 μm for applications in infrared spectroscopy is detailed hereafter. The pump laser emits radiation at 0.532 μm (a YAG-Nd laser with doubled frequency). A crystal of $PbTiOAsO_2$ is machined into a partial

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angular frequency of the emitted waves in the GSH is the second harmonic of the pump wave, i.e., a wavelength $\lambda_h = 2\pi c/2\omega$, with $2\omega = \omega_3$. Table 2 gives for a total rotation of $\delta\alpha = 90°$, the range of pump wavelengths $\Delta\lambda_p$ for which phase tuning by double refraction of the GSH is possible in cylinders of several crystals with non-linear optical properties: $KTiOPO_4$ (KTP), $RbTiOAsO_4$ (RTA), $CsTiOAsO_4$ (CTA), $RbTiOPO_4$ (RTP), and $KTiOAsO_4$ (KTA). Rotation is performed around the Z axis of these crystals (the crystallographic axis c which is the binary axis), from one of the X or Y axes. The calculations are carried out from the phase tuning relationships 1b (equivalent to 1c in the case of GSH) of Example 1. Each crystal, machined into a complete cylinder 1, into a truncated cylinder 3 or into a partial cylinder 5 (cf. Fig. 2) is placed outside or inside a cavity as defined in Example 4 above.

Table 2

Crystal	$\Delta\lambda_p$ (μm)
$KTiOPO_4$	0.99-1.08
$RbTiOAsO_4$	1.14-1.25
$CsTiOAsO_4$	1.27-1.55
$RbTiOPO_4$	1.04-1.15
$KTiOAsO_4$	1.08-1.15

The case of a cylinder of $CsTiOAsO_4$ is detailed hereafter. It is very difficult to obtain spectrally

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input and output mirrors of the cavity may be plane.

Table 3

Material	λp (μm)	Δλs (μm)	Δλi (μm)	Pitch of the grating	Maximum angle of rotation δα (°)
$KTiOPO_4$	0.532	0.62-1.06	1.06-3.5	9.3	50
$KTiOPO_4$	1.064	1.52-2.12	2.13-3.5	36.5	23
$RbTiOAsO_4$	0.532	0.59-1.06	1.06-5.2	15.6	57
$RbTiOAsO_4$	1.064	1.33-2.12	2.13-5.2	34.3	34
$RbTiOPO_4$	0.532	0.62-1.06	1.06-3.5	9.8	49
$RbTiOPO_4$	1.064	1.52-2.12	2.13-3.5	32	25
$LiNbO_3$	0.532	0.59-1.06	1.06-5.2	6.6	56
$LiNbO_3$	1.064	1.33-2.12	2.13-5.2	25.7	36
$CsTiOAsO_4$	0.532	0.59-1.06	1.06-5.2	7.9	56
$CsTiOAsO_4$	1.064	1.33-2.12	2.13-5.2	30	38
$KTiOAsO_4$	0.532	0.59-1.06	1.06-5.2	9.5	55
$KTiOAsO_4$	1.064	1.33-2.12	2.13-5.2	29.5	36

The case of a tunable OPO between 3 μm and 5 μm for applications in optronic counter-measures is detailed hereafter. A structure of $LiNbO_3$ with alternating ferroelectic domains with periodicity 26.26 μm is machined into a truncated cylinder 3 (cf. Fig. 2), with optically polished cylindrical phases. The axis of rotation of the cylinder is the binary Z axis to which the ferroelectric domains are parallel. The periodicity vector V of the structure is perpendicular to this axis and is one of the extreme directions of the cylindrical portion. The other extreme direction of the cylindrical portion is located at 40.5° from the first. The structure is fixed on a motor-driven micrometric rotary support. The portion of

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effective coefficient's sign periodically alternates over a coherence length L_c (cf. Fig. 9). The domains are inverted along the pole axis of the crystals which corresponds to the axis of revolution of the cylinder in accordance with what is described in Examples 7 and 8 above. The angle of rotation is located with respect to the periodicity vector V of the network. The relevant interaction relates to 3 polarized waves along the polar axis. The calculations are carried out from the relationship (17) of Example 7 and from the Sellmeier equations of Example 1.

Each crystal, machined into a complete cylinder 1 or into a truncated cylinder 3 or into a portion 5 of a cylinder (cf. Fig. 2), is placed either outside or inside a cavity such as defined above in Example 4. Fig. 6 illustrates such a device when the crystal is placed inside such a cavity. The focussing and collimating optical system (lenses) is then placed outside this cavity.

Table 4

Material	$\Delta\lambda$ (μm)	Periodicity of the structure $V_\Lambda=2L_c$ (μm)	Maximum angle of rotation $\delta\alpha$ (°)
$KTiOPO_4$	0.8-0.95	3.5	56
$RbTiOPO_4$	0.8-0.95	3.15	58
$RbTiOAsO_4$	0.8-0.95	3.0	58
$LiNbO_3$	0.75-0.95	2.0	64
$LiTaO_3$	0.64-0.95	1.3	76
$CsTiOAsO_4$	0.8-0.95	2.7	60
$KTiOAsO_4$	0.8-0.95	3.0	59